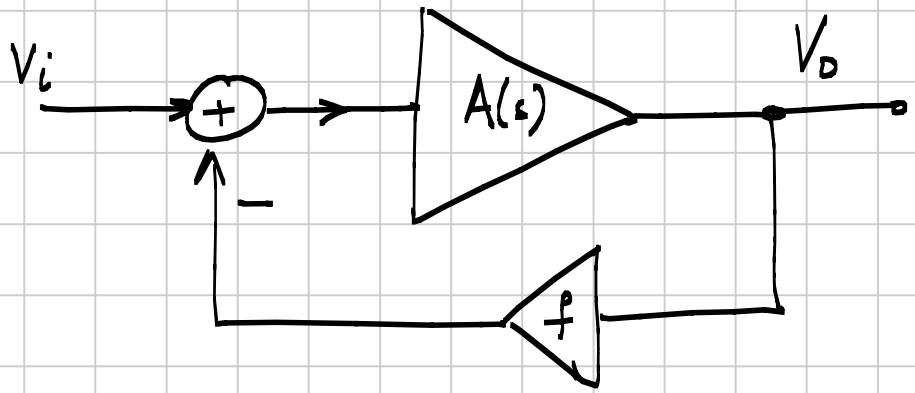
EC5135/EC3102: Analog Circuits
Tutorial 10

1) The Loop gain function of a feedback amplifier is of the form $\dfrac{A_0 f}{\left(1+\frac{s}{\omega_0}\right)^N}$

Determine the maximum allowable $A_0 f$, so that the closed loop system is stable.

2)



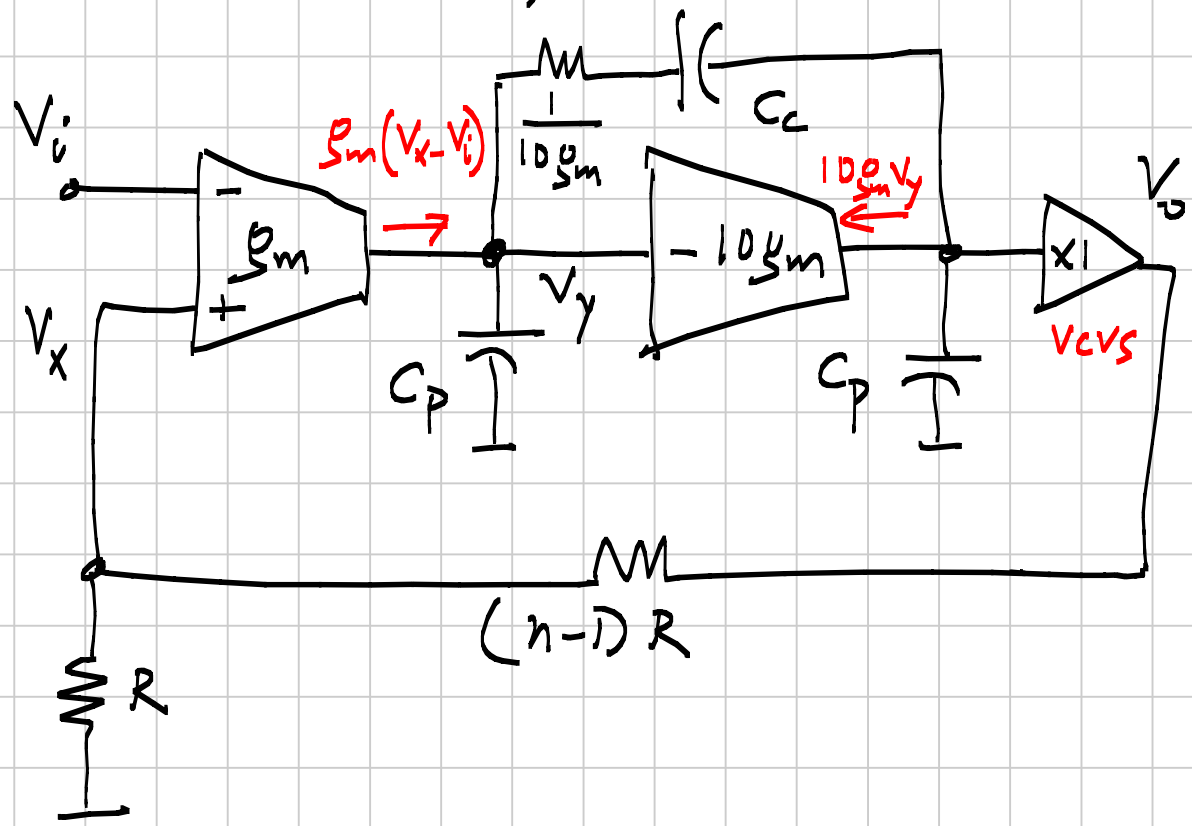
The transfer function of the forward amplifier is known to be

$$A(s) = \frac{10000}{\left(1+\frac{s}{\omega_1}\right)\left(1+\frac{s}{\omega_2}\right)}, \quad \omega_2 > \omega_1$$

The desired closed loop gain is 2, and the Q of the poles of the closed loop system

should not exceed 2. How low should ω_1 be relative to ω_2, to ensure this?

3)



(a) Determine the closed loop DC gain.

(b) For $n=2$, determine the ratio $\frac{C_c}{C_p}$ so that the phase margin of the loop gain function is 60°.

(c) What is the 3dB bandwidth of the transfer function $\frac{V_o(s)}{V_i(s)}$?

(d) Repeat parts (b) & (c) above when the phase margin is chosen as 30°.

4) The gain of many practical opamps can be approximated by

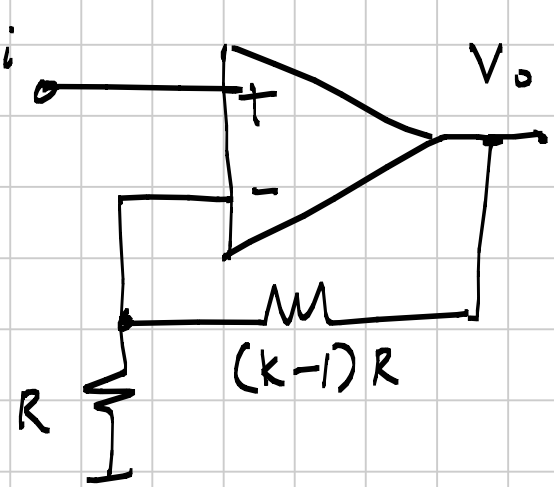
$$A(s) = \frac{A_0}{1 + \frac{s}{\omega_d}}$$, where

$A_0 \to \infty$

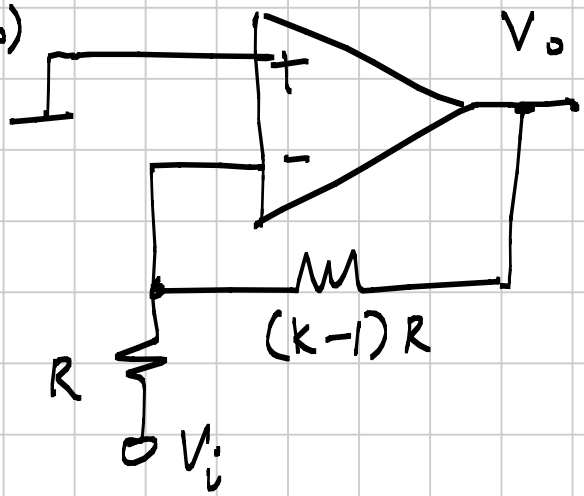
& $\omega_d A_0$ remains constant

Denote $A_0 \omega_d$ by GB

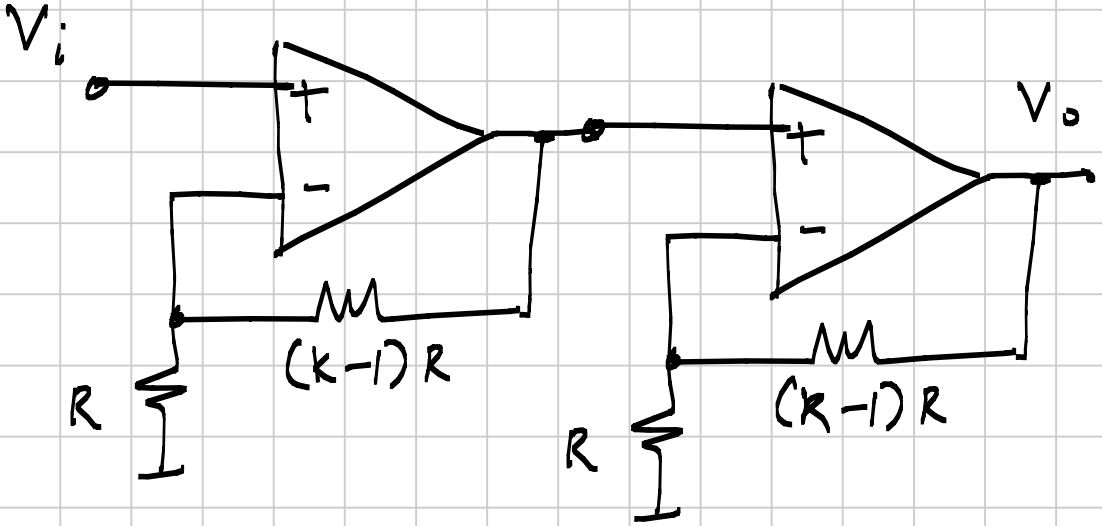
(a)



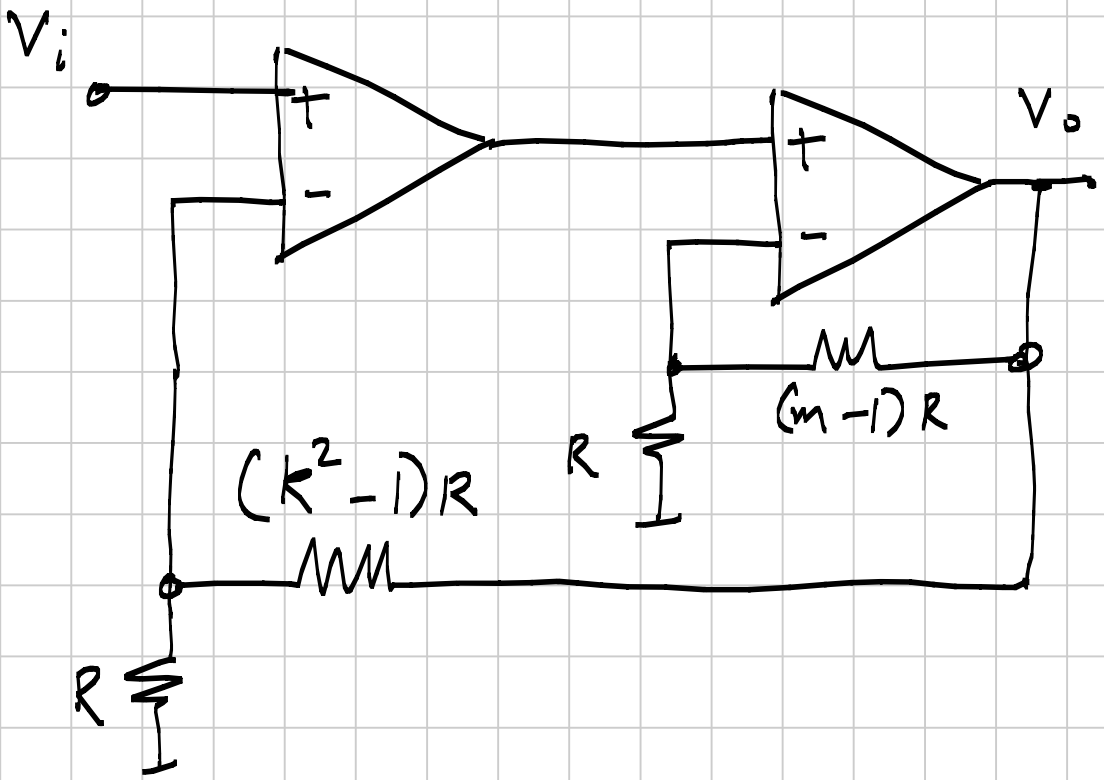
(b)



(c)



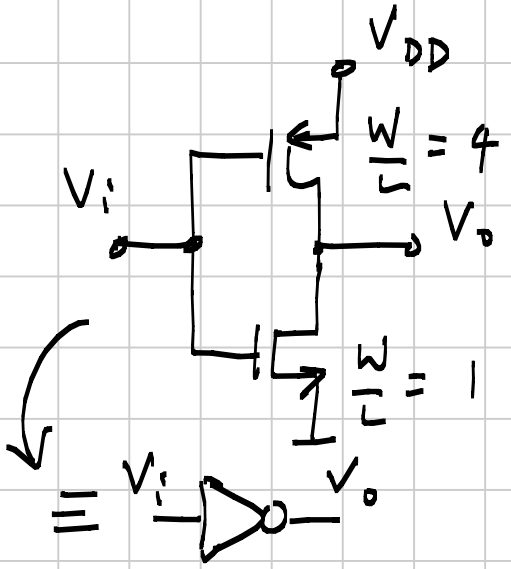
(d)



Determine the transfer functions of each of these amplifiers.

For part (d), determine "m" so that the closed loop transfer function's poles have $\zeta = 1/\sqrt{2}$. Under these circumstances, what is the 3dB bandwidth of the amplifier.

5)



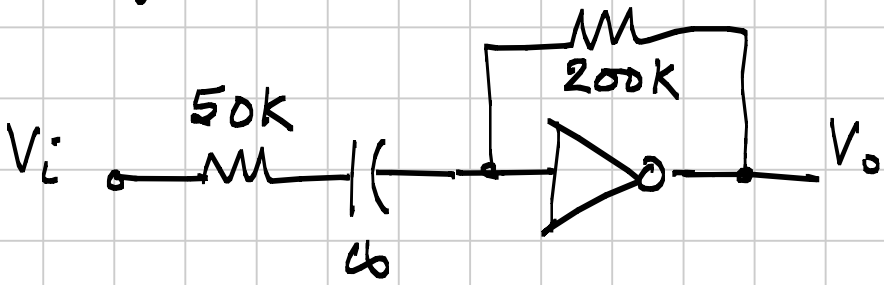
$\mu_n C_{ox} = 100\ \mu A/V^2$

$\mu_p C_{ox} = 25\ \mu A/V^2$

$V_{Tn} = 1V = V_{Tp}$

$V_{DD} = 4\ V$

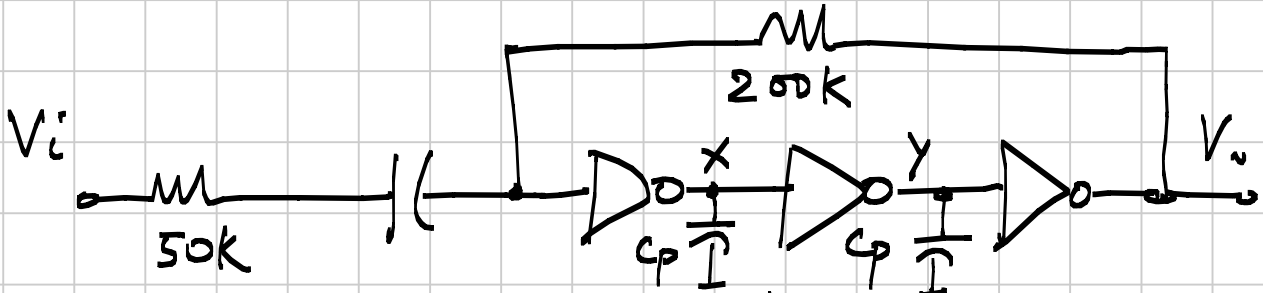
The figure above shows a CMOS inverter.



It is used to make the amplifier shown above.

(a) Determine the DC gain. What would the gain have been if the CMOS inverter had an infinite transconductance?

(b)



To make the effective transconductance larger, a student cascades 3 inverters

as shown. The only parasitics in the network are the capacitors $C_p = 100\,fF$ at nodes X & Y. Determine the transfer function $\frac{V_o(s)}{V_i(s)}$.

What is the DC gain? Quality factor?

(c) To compensate the amplifier a capacitance is to be inserted between X & Y. How large should this be, so that the quality factor = 1? Make approximations where necessary.